PATENT
Attorney Docket No. 401556/TAKADA

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

ABE et al.

Application No. Unassigned

Filed: February 7, 2002

Art Unit: Unassigned

Examiner: Unassigned

For: HIGH-FREQUENCY WAVEGUIDE AND MANUFACTURING METHOD THEREOF

PRELIMINARY AMENDMENT

Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

Prior to the examination of the above-identified patent application, please enter the following amendments and consider the following remarks.

IN THE TITLE:

Replace the title with:

HIGH-FREQUENCY WAVEGUIDE AND METHOD OF MANUFACTURING THE WAVEGUIDE

IN THE SPECIFICATION:

Replace the paragraph beginning at page 1, line 4 with:

The present invention relates to a high-frequency waveguide and a method of manufacturing it, and particularly to a waveguide through which electromagnetic waves lying in a microwave band, a millimeter-wave band and a submillimeter-wave ~~bands~~ band propagate, and a manufacturing method thereof.

Replace the paragraph beginning at page 1, line 10 with:

As a waveguide for allowing electromagnetic waves (hereinafter called "high-frequency waves") lying in ~~a~~ microwave, ~~a~~ millimeter-wave, and ~~a~~ submillimeter wave bands to propagate, a hybrid waveguide comprising a combination of wave guides, metals and a dielectric ~~has~~ have been used. An NRD (nonradiative dielectric) guide with a dielectric interposed between two metal plates has been used as a waveguide in which metals and a dielectric are utilized in combination. As ~~the~~ known references, ~~for example,~~ there are ~~known~~ IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES, VOL. MTT-29, NO. 11, NOVEMBER 1981, PP. 1188-1192, and IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES, VOL. MTT-32, NO. 8, AUGUST 1984, PP. 943-946.

Replace the paragraph beginning at page 1, line 22 with:

While the NRD guide has the feature that no radiation loss is produced at a bent portion of a waveguide, ~~a~~ propagation loss increases because it is used in the neighborhood of a cutoff frequency of the waveguide. In addition to this, a waveguide using a photonic band crystal structure has been placed under study as a waveguide low in radiation loss.

IN THE CLAIMS:

Replace the indicated claims with:

1. (Amended) A high-frequency waveguide comprising:

a first high-frequency reflecting wall including dielectric bars having lengths, each bar comprising a plurality of columnar bodies having respective axes and concentrically varying dielectric constants so that the dielectric constant on the axis is lower than off the axis, the dielectric bars being disposed in plural layers so that the axes of the dielectric bars describe corners of a regular polygon in a plane perpendicular to the axes;

a second high-frequency reflecting wall opposite, spaced from, and parallel to the first high-frequency reflecting wall, with a dielectric interposed between the first and second high-frequency reflecting walls, the second high-frequency reflecting wall including dielectric bars having lengths, each bar comprising a plurality of columnar bodies having respective axes and concentrically varying dielectric constants so that the dielectric constant on the axis is lower than off the axis, the dielectric bars being disposed in plural layers so that the axes of the dielectric bars describe corners of a regular polygon in a plane perpendicular to the axes; and

conductive plates which are opposite each other, with the first and second high-frequency reflecting walls interposed between the conductive plates and end faces of the dielectric bars of the first and second high-frequency reflecting walls connected to the conductive plates.

5. (Amended) The high-frequency waveguide according to claim 1, wherein the dielectric interposed between the first high-frequency reflecting wall and the second high-frequency reflecting wall is air.

6. (Amended) The high-frequency waveguide according to claim 2, wherein the dielectric interposed between the first high-frequency reflecting wall and the second high-frequency reflecting wall is air.

7. (Amended) The high-frequency waveguide according to claims 1, including metal walls located outside the dielectric bars and corresponding to outermost layers of the first and second high-frequency reflecting walls.

8. (Amended) The high-frequency waveguide according to claims 2, including metal walls located outside the dielectric bars and corresponding to outermost layers of the first and second high-frequency reflecting walls.

9. (Amended) The high-frequency waveguide according to claims 3, including metal walls located outside the dielectric bars and corresponding to outermost layers of the first and second high-frequency reflecting walls.

10. (Amended) The high-frequency waveguide according to claims 4, including metal walls located outside the dielectric bars and corresponding to outermost layers of the first and second high-frequency reflecting walls.

11. (Amended) The high-frequency waveguide according to claims 5, including metal walls located outside the dielectric bars and corresponding to outermost layers of the first and second high-frequency reflecting walls.

12. (Amended) The high-frequency waveguide according to claims 6, including metal walls located outside the dielectric bars and corresponding to outermost layers of the first and second high-frequency reflecting walls.

13. (Amended) The high-frequency waveguide according to claim 7, wherein the metal walls respectively comprise metal bar arrays in which metal bars substantially identical in length to the dielectric bars are disposed along the dielectric bars.

14. (Amended) The high-frequency waveguide according to claim 8, wherein the metal walls respectively comprise metal bar arrays in which metal bars substantially identical in length to the dielectric bars are disposed along the dielectric bars.

15. (Amended) The high-frequency waveguide according to claim 9, wherein the metal walls respectively comprise metal bar arrays in which metal bars substantially identical in length to the dielectric bars are disposed along the dielectric bars.

16. (Amended) The high-frequency waveguide according to claim 10, wherein the metal walls respectively comprise metal bar arrays in which metal bars substantially identical in length to the dielectric bars are disposed along the dielectric bars.

17. (Amended) The high-frequency waveguide according to claim 11, wherein the metal walls respectively comprise metal bar arrays in which metal bars substantially identical in length to the dielectric bars are disposed along the dielectric bars.

18. (Amended) The high-frequency waveguide according to claim 12, wherein the metal walls respectively comprise metal bar arrays in which metal bars substantially identical in length to the dielectric bars are disposed along the dielectric bars.

19. (Amended) A method of manufacturing a high-frequency waveguide including :

laminating dielectric bars having lengths, each dielectric bar comprising a plurality of columnar bodies having respective axes and concentrically varying dielectric constants so that the dielectric constant is lower on the axis than off axis, in plural layers so that the axes of the dielectric bars describe corners of a regular polygon in a plane perpendicular to the axes thereby forming first and second high-frequency reflecting walls; and

placing the first and second high-frequency reflecting walls opposite each other, parallel to each other, and spaced from each other, placing conductive plates opposite each other, with the first and second high-frequency reflecting walls interposed between the conductive plates, and connecting the conductive plates to respective end faces of the dielectric bars of the first and second high-frequency walls.

20. (Amended) The method according to claim 19, further including forming metal walls outside the dielectric bars corresponding to outermost layers of the first and second high-frequency reflecting walls.

IN THE ABSTRACT:

Replace the Abstract with:

Abstract of the Disclosure

A first dielectric wall and a second dielectric wall in which hollow alumina cylindrical columns are arranged in layers so that axial centers of the alumina cylindrical columns describe planar triangular lattice arrays, are opposed to each other, and are parallel to air interposed between them. Metal plates are opposed to each other and have end faces of the alumina cylindrical columns interposed between and connected to the metal plates. The first and second dielectric walls and the metal plates are bonded to one another, as a high-frequency waveguide with reduced radiation loss, and that is inexpensive and low in transmission loss.

REMARKS

The foregoing Amendment corrects translational errors and conforms the claims to United States practice. No new matter is added.

Respectfully submitted,

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AMENDMENTS TO SPECIFICATION, CLAIMS AND ABSTRACT MADE VIA PRELIMINARY AMENDMENT

Amendments to the paragraph beginning at page 1, line 4:

The present invention relates to a high-frequency waveguide and a method of manufacturing it, and particularly to a waveguide through which electromagnetic waves lying in a microwave band, a millimeter-wave band and a submillimeter-wave ~~bands~~ band propagate, and a manufacturing method thereof.

Amendments to the paragraph beginning at page 1, line 10:

As a waveguide for allowing electromagnetic waves (hereinafter called "high-frequency waves") lying in ~~a~~ microwave, ~~a~~ millimeter-wave, and ~~a~~ submillimeter wave bands to propagate, a hybrid waveguide comprising a combination of wave guides, metals and a dielectric ~~has~~ have been used. An NRD (nonradiative dielectric) guide with a dielectric interposed between two metal plates has been used as a waveguide in which metals and a dielectric are utilized in combination. As ~~the~~ known references, ~~for example,~~ there are ~~known~~ IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES, VOL. MTT-29, NO. 11, NOVEMBER 1981, PP. 1188-1192, and IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES, VOL. MTT-32, NO. 8, AUGUST 1984, PP. 943-946.

Amendments to the paragraph beginning at page 1, line 22:

While the NRD guide has the feature that no radiation loss is produced at a bent portion of a waveguide, ~~a~~ propagation loss increases because it is used in the neighborhood of

a cutoff frequency of the waveguide. In addition to this, a waveguide using a photonic band crystal structure has been placed under study as a waveguide low in radiation loss.

Amendments to existing claims:

1. (Amended) A high-frequency waveguide~~,~~ comprising:

a first high-frequency reflecting wall ~~wherein~~ including dielectric bars ~~of predetermined~~ having lengths, ~~which respectively comprise~~ each bar comprising a plurality of ~~dielectric constant-different~~ columnar bodies having respective axes and concentrically ~~disposed~~ varying dielectric constants so that ~~their~~ the dielectric ~~constants~~ constant on the ~~axial center sides thereof become low~~ axis is lower than off the axis, ~~are~~ the dielectric bars being disposed in ~~the form of~~ plural layers so that the ~~axial centers~~ axes of the dielectric bars ~~have planar regularities~~ describe corners of a regular polygon in a plane perpendicular to the axes;

a second high-frequency reflecting wall ~~which is~~ opposite, spaced from, and parallel to the first high-frequency reflecting wall ~~in parallel~~, with a dielectric interposed ~~therebetween~~ ~~and wherein~~ between the first and second high-frequency reflecting walls, the second high-frequency reflecting wall including dielectric bars ~~of predetermined~~ having lengths, ~~which respectively comprise~~ each bar comprising a plurality of ~~dielectric constant-different~~ columnar bodies having respective axes and concentrically ~~disposed~~ varying dielectric constants so that ~~their~~ the dielectric ~~constants~~ constant on the ~~axial center sides thereof become low~~ axis is lower than off the axis, ~~are~~ the dielectric bars being disposed in ~~the form of~~ plural layers so that the ~~axial centers~~ axes of the dielectric bars ~~have planar regularities~~ describe corners of a regular polygon in a plane perpendicular to the axes; and

conductive plates which are opposite ~~to~~ each other, with the ~~end faces of the dielectric bodies constituting the~~ first and second high-frequency reflecting walls ~~being~~ interposed ~~therebetween~~ between the conductive plates and ~~which are respectively connected to both~~ end faces of the dielectric bars ~~constituting~~ of the first and second high-frequency reflecting walls connected to the conductive plates.

5. (Amended) The high-frequency waveguide according to claim 1, wherein ~~a~~ the dielectric ~~lying~~ interposed between the first high-frequency reflecting wall and the second high-frequency reflecting wall is air.

6. (Amended) The high-frequency waveguide according to claim 2, wherein ~~a~~ the dielectric ~~lying~~ interposed between the first high-frequency reflecting wall and the second high-frequency reflecting wall is air.

7. (Amended) The high-frequency waveguide according to claims 1, ~~wherein~~ including metal walls ~~are further provided~~ located outside the dielectric bars and corresponding to ~~the~~ outermost layers of the first and second high-frequency reflecting walls.

8. (Amended) The high-frequency waveguide according to claims 2, ~~wherein~~ including metal walls ~~are further provided~~ located outside the dielectric bars and corresponding to ~~the~~ outermost layers of the first and second high-frequency reflecting walls.

9. (Amended) The high-frequency waveguide according to claims 3, ~~wherein~~ including metal walls ~~are further provided~~ located outside the dielectric bars and corresponding to ~~the~~ outermost layers of the first and second high-frequency reflecting walls.

10. (Amended) The high-frequency waveguide according to claims 4, ~~wherein~~ including metal walls ~~are further provided~~ located outside the dielectric bars and corresponding to ~~the~~ outermost layers of the first and second high-frequency reflecting walls.

11. (Amended) The high-frequency waveguide according to claims 5, ~~wherein~~ including metal walls ~~are further provided~~ located outside the dielectric bars and corresponding to ~~the~~ outermost layers of the first and second high-frequency reflecting walls.

12. (Amended) The high-frequency waveguide according to claims 6, ~~wherein~~ including metal walls ~~are further provided~~ located outside the dielectric bars and corresponding to ~~the~~ outermost layers of the first and second high-frequency reflecting walls.

13. (Amended) The high-frequency waveguide according to claim 7, wherein the metal walls respectively comprise metal bar arrays in which metal bars substantially identical in length to the dielectric bars are disposed along the dielectric bars.

14. (Amended) The high-frequency waveguide according to claim 8, wherein the metal walls respectively comprise metal bar arrays in which metal bars substantially identical in length to the dielectric bars are disposed along the dielectric bars.

15. (Amended) The high-frequency waveguide according to claim 9, wherein the metal walls respectively comprise metal bar arrays in which metal bars substantially identical in length to the dielectric bars are disposed along the dielectric bars.

16. (Amended) The high-frequency waveguide according to claim 10, wherein the metal walls respectively comprise metal bar arrays in which metal bars substantially identical in length to the dielectric bars are disposed along the dielectric bars.

17. (Amended) The high-frequency waveguide according to claim 11, wherein the metal walls respectively comprise metal bar arrays in which metal bars substantially identical in length to the dielectric bars are disposed along the dielectric bars.

18. (Amended) The high-frequency waveguide according to claim 12, wherein the metal walls respectively comprise metal bar arrays in which metal bars substantially identical in length to the dielectric bars are disposed along the dielectric bars.

19. (Amended) A method of manufacturing a high-frequency waveguide~~,~~ including ~~the steps of~~:

laminating dielectric bars ~~of predetermined~~ having lengths, each dielectric bar comprising a plurality of ~~dielectric constant-different~~ columnar bodies having respective axes and concentrically ~~disposed~~ varying dielectric constants so that ~~their~~ the dielectric ~~constants become low~~ constant is lower on the ~~axial center sides thereof~~ axis than off axis, in ~~the form of such~~ plural layers so that the ~~centers~~ axes of the dielectric bars ~~have planar regularities to~~ describe corners of a regular polygon in a plane perpendicular to the axes thereby ~~form~~ forming first and second high-frequency reflecting walls; and

~~opposing~~placing the first and second high-frequency reflecting walls ~~to~~ opposite each other, ~~in~~ parallel to each other, and spaced from each other, ~~opposing~~ placing conductive plates ~~to~~ opposite each other, with ~~end faces of the dielectric bars constituting~~ the first and second high-frequency reflecting walls ~~being~~ interposed ~~therebetween~~ between the conductive plates, and connecting the conductive plates to ~~both~~ respective end faces of the dielectric bars ~~constituting~~ of the first and second high-frequency walls ~~respectively~~.

20. (Amended) The method according to claim 19, further including ~~a step of~~ forming metal walls outside the dielectric bars corresponding to ~~the~~ outermost layers of the first and second high-frequency reflecting walls.

Amendments to the abstract:

Abstract of the Disclosure

A first dielectric wall and a second dielectric wall in which hollow alumina cylindrical columns are arranged in ~~a layered form~~ layers so that ~~the~~ axial centers of the

alumina cylindrical columns ~~have~~ describe planar triangular lattice arrays, are opposed to each other~~, in~~ and are parallel ~~with~~ to air interposed ~~therebetween~~ between them. Metal plates are opposed to each other ~~with both~~ and have end faces of the alumina cylindrical columns ~~constituting the first dielectric wall and the second dielectric wall being~~ interposed ~~therebetween~~ between and connected to the metal plates. ~~Further, the~~ The first and second dielectric walls ~~and~~ and the metal plates are bonded to one another~~, whereby~~ as a high-frequency waveguide ~~is configured which is~~ with reduced ~~in~~ radiation loss, and that is inexpensive and low in transmission loss.

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PENDING CLAIMS AFTER ENTRY OF PRELIMINARY AMENDMENT

1. A high-frequency waveguide comprising:

a first high-frequency reflecting wall including dielectric bars having lengths, each bar comprising a plurality of columnar bodies having respective axes and concentrically varying dielectric constants so that the dielectric constant on the axis is lower than off the axis, the dielectric bars being disposed in plural layers so that the axes of the dielectric bars describe corners of a regular polygon in a plane perpendicular to the axes;

a second high-frequency reflecting wall opposite, spaced from, and parallel to the first high-frequency reflecting wall, with a dielectric interposed between the first and second high-frequency reflecting walls, the second high-frequency reflecting wall including dielectric bars having lengths, each bar comprising a plurality of columnar bodies having respective axes and concentrically varying dielectric constants so that the dielectric constant on the axis is lower than off the axis, the dielectric bars being disposed in plural layers so that the axes of the dielectric bars describe corners of a regular polygon in a plane perpendicular to the axes; and

conductive plates which are opposite each other, with the first and second high-frequency reflecting walls interposed between the conductive plates and end faces of the dielectric bars of the first and second high-frequency reflecting walls connected to the conductive plates.

2. The high-frequency waveguide according to claim 1, wherein the dielectric bars are cylindrical.

3. The high-frequency waveguide according to claim 1, wherein the dielectric bars are hollow.

4. The high-frequency waveguide according to claim 2, wherein the dielectric bars are hollow.

5. The high-frequency waveguide according to claim 1, wherein the dielectric interposed between the first high-frequency reflecting wall and the second high-frequency reflecting wall is air.

6. The high-frequency waveguide according to claim 2, wherein the dielectric interposed between the first high-frequency reflecting wall and the second high-frequency reflecting wall is air.

7. The high-frequency waveguide according to claims 1, including metal walls located outside the dielectric bars and corresponding to outermost layers of the first and second high-frequency reflecting walls.

8. The high-frequency waveguide according to claims 2, including metal walls located outside the dielectric bars and corresponding to outermost layers of the first and second high-frequency reflecting walls.

9. The high-frequency waveguide according to claims 3, including metal walls located outside the dielectric bars and corresponding to outermost layers of the first and second high-frequency reflecting walls.

10. The high-frequency waveguide according to claims 4, including metal walls located outside the dielectric bars and corresponding to outermost layers of the first and second high-frequency reflecting walls.

11. The high-frequency waveguide according to claims 5, including metal walls located outside the dielectric bars and corresponding to outermost layers of the first and second high-frequency reflecting walls.

12. The high-frequency waveguide according to claims 6, including metal walls located outside the dielectric bars and corresponding to outermost layers of the first and second high-frequency reflecting walls.

13. The high-frequency waveguide according to claim 7, wherein the metal walls respectively comprise metal bar arrays in which metal bars substantially identical in length to the dielectric bars are disposed along the dielectric bars.

14. The high-frequency waveguide according to claim 8, wherein the metal walls respectively comprise metal bar arrays in which metal bars substantially identical in length to the dielectric bars are disposed along the dielectric bars.

15. The high-frequency waveguide according to claim 9, wherein the metal walls respectively comprise metal bar arrays in which metal bars substantially identical in length to the dielectric bars are disposed along the dielectric bars.

16. The high-frequency waveguide according to claim 10, wherein the metal walls respectively comprise metal bar arrays in which metal bars substantially identical in length to the dielectric bars are disposed along the dielectric bars.

17. The high-frequency waveguide according to claim 11, wherein the metal walls respectively comprise metal bar arrays in which metal bars substantially identical in length to the dielectric bars are disposed along the dielectric bars.

18. The high-frequency waveguide according to claim 12, wherein the metal walls respectively comprise metal bar arrays in which metal bars substantially identical in length to the dielectric bars are disposed along the dielectric bars.

19. A method of manufacturing a high-frequency waveguide including :

laminating dielectric bars having lengths, each dielectric bar comprising a plurality of columnar bodies having respective axes and concentrically varying dielectric constants so that the dielectric constant is lower on the axis than off axis, in plural layers so that the axes of the dielectric bars describe corners of a regular polygon in a plane perpendicular to the axes thereby forming first and second high-frequency reflecting walls; and

placing the first and second high-frequency reflecting walls opposite each other, parallel to each other, and spaced from each other, placing conductive plates opposite each other, with the first and second high-frequency reflecting walls interposed between the conductive plates, and connecting the conductive plates to respective end faces of the dielectric bars of the first and second high-frequency walls.

20. The method according to claim 19, further including forming metal walls outside the dielectric bars corresponding to outermost layers of the first and second high-frequency reflecting walls.